University Of Utah Electromagnetic Modeling In Support Of Undersea Sensor Systems

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LONG-TERM GOAL

The long term goal is to develop low frequency electromagnetic models for a) frequency domain and time domain 3-D forward prediction capabilities that include conductivity anisotropy, magnetic susceptibility, and geometric effects, b) fast imaging of surface, airborne, and borehole electromagnetic data, c) multidimensional electromagnetic inversion for airborne, surface, sea bottom and borehole EM observations.

OBJECTIVE

The objective is to improve the Navy's EM forward modeling and data interpretation capability in a cost effective manner using academic resources and leveraging industry and other agency development efforts.

APPROACH

Participate in the University of Utah consortium on EM modeling and Inversion under the direction of Dr. Zhdanov. Selected algorithms and software modules will be installed, tested and integrated into NRL's EM modeling effort using a sun workstation network. The models will become part of the Navy low frequency EM modeling capability. NRL will manage the project and select algorithms for integration.

WORK COMPLETED

The University of Utah consortium has made a number of accomplishments during the previous year. A group of eight graduate students and four professors have produced sixteen papers detailing the results of new methods in EM model development. New model developments have included:

- A new Fortran 77 library for computing the normal fields and volume integrals of electromagnetic Green's tensors in layered anisotropic Earth.

- A new generation of Integral Equation methods using compression techniques which possess flexibility in forward simulations compatible with the flexibility of Finite Difference modeling, but which preserved the high level of accuracy typical for Integral Equation techniques.

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- Increased the accuracy of the Quasi-Analytic (QA) approximation of the by constructing QA approximations of a higher order.

- Developed and demonstrated that focusing inversion could generate more focused and clear images for geological structures than regularization based on conventional maximum smoothness or total variation functionals.

RESULTS

The University of Utah consortium has made a number of accomplishments during the previous year. A group of eight graduate students and four professors have produced sixteen papers detailing the results of new methods in EM model development.

IMPACT/APPLICATION

This work is focused on improving the Navy's EM forward modeling and data interpretation capability in a cost effective manner using academic resources and leveraging industry and other agency development efforts. Application of these numerical techniques has been used to relate the sea bottom electrical properties to the local sediment distributions and the influence these factors have on MCM operations. The connection between the sediment properties and the resulting MCM environmental parameters is poorly understood. Also these models are being used in work to determine the effects of multiple influence systems for ASW applications.

TRANSITIONS

Models from this work have been transitioned to the NRL Multiple-Influence Detection task and in the ONR sponsored work in Environmental Characterization For EM Techniques in MCM.

RELATED PROJECTS

Related projects include the NRL Multiple-Influence Detection task, which has investigated the effects of the environment on data fusion of different sensor types for ASW applications.

PUBLICATIONS

Yongliang Meng, Weidong Li, Yanzhong Luo, and Michael Zhdanov, 2.5-D Electromagnetic Forward Modeling in the Time and Frequency Domains Using the Finite Element Method: CEMI Annual Meeting, 1999.

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Oleg Portniaguine, Application of the Controlled Source Magnetotelluric (CSMT) Method for Oil Exploration in Hamlin Valley, Nevada: CEMI Annual Meeting, 1999.

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Oleg Portniaguine and Michael Zhdanov, Compression in Inverse Problem Solution: CEMI Annual Meeting, 1999.